Safety Belt Use in Automobiles with Starter-Interlock and Buzzer-Light Reminder Systems

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Data from visual observation of use or nonuse of safety belts by drivers are used to compare the effectiveness of buzzer-light and starter-interlock reminder systems in automobiles.

Introduction

When a moving vehicle decelerates abruptly, as in a crash with another vehicle or with other sufficiently unyielding objects in the environment, unrestrained occupants are thrown about in or out of the vehicle. Unrestrained occupants of crash-involved vehicles are often injured when they strike interior surfaces of the vehicle or the external environment when they are thrown out. An average of nearly 13,000 people per day were injured in or by motor vehicles sufficiently to require at least 1 day of restricted activity in 1972.[1] By late 1973 a total of 2 million people had died in the U.S. as a result of motor vehicle crashes since the introduction of such vehicles as a mode of travel.[2]

Ameliorative Strategies

There are well known means of controlling the energy of moving vehicles and occupants such that the damage to them and the people or objects they strike is reduced. Some of these, such as steering assemblies that yield at a controlled rate in a collision and windshields that take up energy like a fire net, have been required by federal standard in vehicles manufactured for sale in the U.S. since January 1, 1968.[3,4] Air cushions that inflate in a crash and deflate at a controlled rate, absorbing the energy of decelerating vehicle occupants, have been tested for nearly a decade but have been placed in only a very limited number of vehicles on the roads.

One of the means of attenuating the energy of vehicle occupants in crashes is to restrain their movement by safety belts.[5] In contrast to other means of energy management mentioned, use of safety belts now available requires the active cooperation of the vehicle occupant. The term "active" is applied to public health strategies that require that each individual person to be protected must take appropriate action to protect himself. "Passive" strategies, such as energy-absorbing steering assemblies in motor vehicles, breakaway roadside poles, purified water, and shielded electrical cables, do not require action by the individual to be protected.[6,7] Since each individual may not be aware of the danger in his environment or the efficacy of a particular protective action, or may not take the action because of inconvenience, inability, or whatever, passive strategies are clearly preferable to active strategies, and have a much better record of success.

Lap belts became standard equipment in the driver's and some other seating positions of most automobiles in the U.S. after 1964, when a number of states passed laws requiring their installation.[8] Under the mandate of the National Traffic and Motor Vehicle Safety Act of 1966, the then National Traffic Safety Agency issued a standard in early 1967 requiring lap belts and shoulder harnesses in the front outboard seating positions, and lap belts in other seating positions, of all but a few excepted automobiles manufactured for sale in the U.S., effective January 1, 1968.[8] However, a 1970 survey involving actual observation of drivers in equipped vehicles revealed that lap belts were

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used by less than 1 in 4 and shoulder harnesses by less than 1 in 20.[9] Studies using questionnaire surveys that had reported belt use rates of 40 per cent were shown to be invalid by a 1969 study that found that 23 per cent of persons observed not wearing belts in their home town claimed, in a follow-up questionnaire, to wear them "always" on short trips. Over one-half of those observed not wearing belts some distance from their home towns claimed to use them "always" on long trips.[10]

Effective August 15, 1973, a federal standard[11] required a belt system that allows the automobile to start only under certain conditions. In the case of the driver's seating position, the following sequence is required: the driver is seated, and the belts are extended more than 4 inches from their normally stowed position and/or are latched. For the right front seating position, when it is occupied by specified minimum weights before starting the vehicle, the belt must be extended 4 inches and/or latched before the car will start. If the front positions are occupied by specified minimum weights after the vehicle is started or if the driver or a front seat occupant releases the belts, a buzzer-light system is activated.

Inertia reels that allow freedom of movement under noncrash conditions but lock to restrain the belt wearer under potentially hazardous deceleration forces are also required in front outboard seating positions. Although detachable shoulder harnesses are allowed if the lap belt meets certain crash test requirements, all major manufacturers have chosen to install single latch belts with nondetachable shoulder harnesses, that is, so-called three point belts. With the exception of a few thousand automobiles produced with cushions that inflate on severe impact, all 1974 automobiles have interlock systems in lieu of passive restraints.

An earlier federal standard, effective from January 1, 1972, through August 14, 1973,[12] required passenger vehicles manufactured for sale in the U.S. to have passive protection for vehicle occupants in frontal barrier crashes up to and including 30 miles per hr or, in the alternative, a buzzer-light system to remind occupants of front outboard seats when lap belts were not fastened. Under the latter option, the light—visible to the driver, displaying the words "Fasten Seat Belts" or "Fasten Belts"—and buzzer are activated for at least 1 minute when the driver's seat is first occupied, the ignition switch is on, the transmission gear selector is in any forward position, and the driver's lap belt is not extended at least 4 inches from its normally stowed position. The system also is activated for at least 1 minute when a person of specified minimum weight occupies the right front outboard seat without a 4-inch extension of the lap belt when the ignition is on and the transmission gear is in any forward position. With a few exceptions—including a few thousand automobiles equipped with cushions that inflate in severe frontal crashes, sold initially for field testing purposes in corporate fleets—vehicles manufactured from January 1, 1972, to August 15, 1973, and had the buzzer-light system in lieu of passive protection.

Both the interlock system and the buzzer-light system can be circumvented, each in a number of ways. It cannot be assumed that vehicle occupants will necessarily be induced to use belts by the mere presence of these devices in the vehicle. The present study was undertaken to document the extent of belt use in vehicles with the noted equipment.

Method

Use or nonuse of safety belts by drivers in their vehicles was visually observed at 138 sites in Baltimore, Maryland; Houston, Texas; Los Angeles, California; the New Jersey suburbs of New York City; Richmond, Virginia; and Washington, DC in late 1973 and early 1974. Before assignment of observers to sites, the sites were checked by the author to ensure that belt use could be seen. Sites were chosen where belt use could best be seen in daylight from the side of the vehicle opposite to the driver. Sites were at freeway entrances and exits, jam areas, and other points where vehicles ordinarily slow to less than 15 miles per hr.

Observers tape-recorded the sex, estimated age, and racial appearance of the driver of the approaching passenger car. When the vehicle was alongside, the observer recorded use of lap belt, shoulder belt, or no belt, or that belt use was unknown because of configuration of clothing, obstructed vision, vehicle speed, or whatever. As the vehicle moved on, the rear license plate number was recorded.

Although the observers obviously knew that this was a study of belt use, they did not know that the buzzer-light and interlock systems were being compared. They were told to observe every passenger vehicle that they could at a comfortable pace, giving no preference to vehicles of any age. They were told to ignore trucks and vans. The drivers had no way of anticipating that they would be observed.

The license plate numbers subsequently were sent to the appropriate motor vehicle administrations in California, the District of Columbia, Maryland, New Jersey, Texas, and Virginia, where they were matched to administration records. This yielded vehicle identification numbers, and hence, manufacturer and year of manufacture. In addition, date of initial registration was provided by four of the motor vehicle administrations.

A validation study of the observation method was accomplished by independently verifying a sample of observations unbeknownst to the observers. In one city this was done by having drivers in a fleet of vehicles meet the author at a designated place, where their belt use and license plate numbers were recorded. A number of drivers who did not have belts on were asked to wear them, but no one who was wearing a belt was asked to remove it. They were instructed to drive a designated route, which unbeknownst to them would take them by one or more observers, and return to the author, who observed whether or not their belt use was the same as when they left. In two other cities the author and an assistant checked the belt use of stopped or very slowly moving drivers a short distance before or after they passed observers. In the cases where the drivers were sent by observers, the observations of those vehicles sent were removed from the final analysis.

Results

Validation Study. A total of 206 observations were made of vehicles that were either sent (N = 53) or checked (N = 153) as to driver's belt use. Table 1 presents the comparison of the observers' reports and the belt use indicated by the sender or checker. Eliminating the 16 cases (eight per cent) where the observer indicated "can't see," 86 per cent of the observers' reports agreed with belt use indicated by the sender or checker. The pattern of observations indicates that by eliminating those observations that are reported as "can't see," as has been done in studies using this method, the percentage of shoulder belt use reported by the observers (16 per cent) is the same as that sent or checked, and that percentage of lap belt use reported by observers (22 per cent) is five percentage points less than it should be according to the sender or checker (27 per cent).

Belt Systems. The percentage of drivers using lap and shoulder belts, lap belts only, or no belts in vehicles compared by type of belt-wearing inducement system is shown in Table 2. Drivers in 48 per cent of the 1974 vehicles equipped with the interlock system were using lap and shoulder belts, and 11 per cent were using lap belts only, a total use rate of 59 per cent. In 1973 vehicles equipped with the buzzer-light system, only 7 per cent of drivers were using lap *and* shoulder belts, and 21 per cent were using lap belts only, a total use rate of 28 per cent.

Table 3 presents a comparison of belt use in 1972 vehicles between those equipped with the buzzer-light system and those not so equipped. Twenty-five per cent of drivers were using one or both belts in the buzzer-light-equipped vehicles and 23 per cent were using one or both belts in nonequipped vehicles. Drivers were using belts in 20 per cent of the 24,968 observed vehicles manufactured before 1972.

TABLE 1—Belt Use Reported by Observers in Vehicles Sent by Them or Independently Checked before or after the Observation

Belt Use Reported by Observer	Belt Use in Vehicles Sent or Checked		
	Shoulder	Lap only	No belt
Shoulder	28	2	0
Lap only	3	33	6
No belt	0	15	103
Can't see	1	6	9

	Percentage Sent or Checked	Percentage Observed (Excluding Can't See)
Shoulder	16	16
Lap only	27	22
No belt	57	62

TABLE 2—Comparison of Belt Use in 1973 Automobiles Equipped with Buzzer-Light Systems and 1974 Automobiles Equipped with Interlock Systems*

Belt Use	1973 Models Buzzer-Light-Equipped		1974 Models Interlock-Equipped	
	%	No.	%	No.
Lap and shoulder	7	432	48	1007
Lap only	21	1262	11	227
None	72	4257	41	867
Total	100	5951	100	2101

Yates Corrected $\chi^2 = 1751.95$, df = 2, $p \ll 0.001$

* Excludes 864 cases (10 per cent) where the observer indicated "can't see."

TABLE 3—Comparison of Belt Use in 1972 Automobiles by Whether or Not the Vehicle was Equipped with the Buzzer-Light System*

Safety Belt	Buzzer-Light-Equipped				
	Yes		No		
	%	No.	%	No.	Total
In use	25	534	23	320	854
Not in use	75	1551	77	1051	2602
Total	100	2085	100	1371	3456

Yates Corrected $\chi^2 = 2.16$, df = 1, $p > 0.50$

* Excludes 390 cases (10 per cent) for which the observer indicated "can't see," 569 cases where information on the buzzer-light system was unavailable, and 777 cases in New Jersey where vehicle identification numbers were not available.

It is conceivable that people are influenced by the interlock to use belts when they first encounter the system, but later circumvent the system. If this were the case, belt use should be consistently less for drivers who have owned their cars longer. Also, in those cases where the driver is not the owner, he may be reluctant to disconnect the system, whereas he might do so in his personal car.

Data on belt use by date of registration of privately owned interlock-equipped vehicles are shown in Table 4. Belt use in vehicles registered in September and October, November, and December to February did not increase or decrease consistently over the respective time periods. As can be seen in Table 5, ownership was associated with a difference in use in the case of rental vehicles. Drivers of rental cars were using belts significantly more often than drivers of cars owned by individuals.

Our previous study of the buzzer-light system in 1972 cars found no differences in belt use among vehicles of different manufacturers.[13] However, belt use did differ by race, but not age and sex of drivers—blacks used belts less often than whites. In the present study, the same comparisons in 1974 vehicles produced different results.

TABLE 4—Percentage Safety Belt Use in 1974 Vehicles by Date of Registration*

	Registration Date						
	September–October		November		December–February		
Belt Use	%	No.	%	No.	%	No.	Total
Lap and shoulder	51	72	55	123	47	216	411
Lap only	13	19	11	25	12	53	97
None	36	51	34	76	41	189	316
Total	100	142	100	224	100	458	824

$\chi^2 = 4.61$, df = 4, $p > 0.80$ (not statistically significant)

* Vehicles owned by individuals only. Excludes 770 vehicles owned by corporations and an additional 422 vehicles for which registration date was unavailable.

TABLE 5—Percentage Safety Belt Use in 1974 Vehicles by Type of Ownership*

	Ownership							
	Individuals		Rental		Lease		Other corporate	
Belt Use	%	No.	%	No.	%	No.	%	No.
Lap and shoulder	47	583	64	145	47	86	51	182
Lap only	11	139	10	24	13	24	9	31
None	42	524	26	59	40	74	40	145
Total	100	1246	100	228	100	184	100	358

χ^2 (individuals vs. rental) = 23.845, df = 2, $p < 0.001$

* Excludes 157 cases where the observer indicated "can't see" and 85 cases where ownership was ambiguous.

Table 6 compares percentage belt use in 1974 vehicles by manufacturer of vehicle where there are sufficient numbers of observed vehicles for comparison. Belt use was highest in cars produced by General Motors (64 per cent, including lap only), followed by Toyota (62 per cent), American Motors (61 per cent), Chrysler (61 per cent), Ford (56 per cent), and Volkswagen (47 per cent).

Racial differences in belt use in 1974 cars were not statistically significant (Table 7). The differences by age showed less use of any belts by drivers under 30 and greater use of the lap belt without the shoulder belt by drivers 50 and older (Table 8). Comparison of men and women drivers revealed a somewhat higher rate among men and a tendency for women to use the lap belt without the shoulder belt more often than men (Table 9).

Conclusions

This study indicates that belt use was increased in urban areas by the introduction of the interlock system in 1974 vehicles. At least a lap belt was in use twice as frequently in 1974 vehicles equipped with the interlock system as in 1973 vehicles equipped with the buzzer-light system, observed under the same conditions. In spite of the interlock system, however, 41 per cent of drivers in the 1974 vehicles were not using any belts. Thus, they continued to be unprotected by restraint systems in low to moderate speed, as well as high speed, crashes.

The differences in belt use between 1974 vehicles and 1973 vehicles is much greater than year-to-year differences in belt use observed in our earlier study,[13] at least during the first few months of the interlock availability. The similarity of belt use in vehicles recently registered compared to those registered a few months earlier suggests that the interlock's effect on belt use persists for at least a few months. Observation of equipped vehicles after they have been in use for longer periods of time will be required before it can be assumed that the effect is permanent.

Two studies of 1974 model cars have reported higher use rates in interlock-equipped cars than those observed here. Ford Motor Company reported 63 per cent lap-and-shoulder belt use among drivers who responded to a request to appear at a predesignated site for an interview about their new Ford-produced car.[14] In a press release General Motors reported 58 per cent lap-and-and shoulder belt use by drivers in General Motors 1974 model cars observed in

TABLE 6—Belt Use in 1974 Interlock-Equipped Automobiles Compared by Manufacturer*

	Manufacturer											
	General Motors		Toyota		American Motors		Chrysler		Ford		Volkswagen	
Belt Use	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
Lap and shoulder	53	498	52	25	46	36	44	74	49	285	35	33
Lap only	11	102	10	5	15	12	17	29	7	43	12	11
None	36	334	38	18	38	30	39	67	44	259	54	51
Total	100	934	100	48	99	78	100	170	100	587	101	95

$\chi^2 = 28.13$, df = 10, $p < 0.01$

* Excludes 189 observed vehicles of other manufacturers, the number for each of these other manufacturers being too small for analysis.

TABLE 7—Driver Belt Use in 1974 Interlock-Equipped Automobiles Compared by Racial Appearance of Driver*

	Racial Appearance			
	White		Black	
Belt Use	%	No.	%	No.
Lap and shoulder	47	866	49	116
Lap only	11	206	8	20
None	41	757	43	102
Total	99	1829	100	238

$\chi^2 = 1.775$, df = 2, $p > 0.20$ (not statistically significant)

* Excludes 34 cases in which racial appearance was indicated as "other."

TABLE 8—Belt Use in 1974 Interlock-Equipped Automobiles Compared by Estimated Age of Driver*

	Age					
	Under 30		30–49		50 or More	
Belt Use	%	No.	%	No.	%	No.
Lap and shoulder	45	206	50	580	45	213
Lap only	8	36	11	125	14	65
None	47	213	39	459	41	192
Total	100	455	100	1164	100	470

$\chi^2 = 14.06$, df = 4, $p < 0.01$

* Excludes 12 cases in which age was not estimated by the observer.

use at various sites in the Detroit metropolitan area. The difference in percentage of belt use between the Ford study and the General Motors study is the reverse of that found in this study, where Ford-produced cars were found to have less belt use than General Motors-produced cars. The Ford report did not indicate what proportion of the new car owners who were invited to the interview actually appeared. The manager of car marketing research wrote the author that in an earlier Ford study of the buzzer-light system in 1972 cars, using the same type of invitation, only 20 per cent of drivers invited to bring in their cars actually did so. On the basis of decades of documentation by behavioral scientists and others, such a sampling procedure or response is inadequate even for a marketing study of nonsafety-related aspects of cars, and particularly so when the issue involves the potential of injury to large numbers of vehicle occupants.

The difference in percentage of belt usage between the General Motors study and the study reported here, using similar methods, could represent differences in the cities studied or the mix of city and suburban sites used in the two studies. General Motors reported 40 per cent belt usage in 1974 cars observed in the city compared to 65 per cent usage in those observed in the suburbs.

The large differences among usage rates in vehicles produced by different manufacturers could be a result of differences in the equipment installed, manufacturer and dealer communications regarding belts, and possibly other factors. The smaller or nonexistent differences in belt usage found between races, sex, and age groupings suggest that, if human differences are involved, they are not systematically distributed by race and only to a small degree by sex and age.

Although the percentages were different, the lack of difference in belt use between buzzer-light-equipped and nonequipped vehicles in the 1972 model year was the same as that reported in our 1972 study using the same methods.[13] Other studies have reported differences in buzzer-light-equipped and nonequipped vehicles, but these involved drivers in company-owned vehicles in one case[15] and drivers that volunteered to bring their cars in for interviews in another,[16] or included an unreported proportion of studied drivers who were interviewed about belt use after being stopped on the road.[17] In the first instances the principles of scientific sampling were violated; in the latter, the overestimate of belts use rates from interview data, scientifically well documented,[10] was ignored.

The validation study reported here shows some underestimation of use of lap belts without the shoulder harness but the error is less than that found in studies finding overestimates using interviews. The error encountered in

TABLE 9—Driver Belt Use in 1974 Interlock-Equipped Automobiles Compared by Sex of Driver

Belt Use	Sex			
	Female		Male	
	%	No.	%	No.
Lap and shoulder	44	267	50	739
Lap only	14	85	10	142
None	43	261	40	606
Total	101	613	100	1487

$\chi^2 = 11.25$, df = 2, $p < 0.01$

using the observation method is not sufficient to invalidate the conclusions of this and earlier studies using the method.

Adequate observation methods and samples are essential to avoid bias both by the observers and the observed. This is best accomplished when observers do not know the specific purpose of the study and the observed persons cannot anticipate the observation and perhaps alter their behavior accordingly. Inaccurate estimates of safety belt use can be expected from use of measures that allow possible observer bias or allow the observed to anticipate and possibly react to the observation situation. By use of appropriate scientific methods, these problems were avoided in the work reported here.

Also essential to effective public policy is rational decision-making based on the results of well designed and executed research. Curiously, the decision by the National Highway Traffic Safety Administration to adopt the standard allowing the interlock belt system as an alternative to passive restraints was made in spite of the fact that the Administration's own study of rental cars especially equipped with various combinations of buzzer-light and interlock systems showed no significant difference in belt use among drivers in cars with different types of systems.[18]

The present study shows that belt use in interlock-equipped cars is higher in rental than in privately owned cars. Use of belts in rental cars could be affected by the select population who rent cars, the fact that the cars are not their own, the way in which the cars are maintained, and the like. However, such considerations are nowhere evident in the deliberations that preceded the issuance of the interlock standard. After being presented with the rental car study, the National Motor Vehicle Safety Advisory Council recommended in its March 15, 1973, meeting "that the National Highway Traffic Safety Administration withdraw those provisions of FMVSS 208 which require starter restraint system interlocks," but the recommendation was unheeded. Thus, the improved belt use in 1974 vehicles was not one based on a standard developed from testing in the field.

The increased belt use in 1974 vehicles will undoubtedly reduce the incidence and severity of injury in these vehicles. In Australia, when safety belt use was required by law, belt use rates increased to 60 per cent in rural and to 75 per cent in urban areas during the first year of the law, accompanied by significant reductions in fatalities[19] and serious spinal cord injuries that result in paralysis.[20] As in the case of the interlock, there is a possibility that the effects of safety belt use laws are temporary.[21] Further study will be necessary to document the degree to which the effects are sustained.

As a result of strong negative public reaction to the interlock system, a federal law has banned the interlock.[22] A similar public reaction to passive approaches is not anticipated because they are not obtrusive in people's daily lives, as was the interlock. For example, there was no serious public reaction when passive approaches such as the energy-absorbing steering assembly were required in new cars.

The U.S. Department of Transportation has issued a notice of a proposed standard for 1977 model and subsequent passenger vehicles that would require passive protection to all front seat occupants in 30 mile per hr frontal and angular and 20 mile per hr lateral crashes into test barriers.[23] Such a proposal was originally issued in 1969, with a January 1, 1972, effective date. The options that allowed buzzer-light and interlock systems were among the compromises that allowed the delay in implementation of the passive standard. Evaluations of current passive restraint technology indicate that it is possible not only to meet but to exceed the protection required in the standard for 1977 cars.[24]

Addendum: A similar survey in the spring of 1975 found that belt use in interlock-equipped cars was 33 per cent.

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HARVARD UNIVERSITY ANNOUNCES EXECUTIVE PROGRAM IN HEALTH POLICY, PLANNING, AND REGULATION

The Harvard University Executive Programs in Health Policy and Management is offering the "Executive Program in Health Policy, Planning, and Regulation." This program will be held at the Harvard School of Public Health, in Boston, from March 14 through April 9, 1976.

The program has been designed primarily for health professionals who hold senior positions in such agencies as state health departments, Medicaid programs, Professional Standards Review Organizations, rate-setting bodies, and Comprehensive Health Planning agencies. Individuals from appropriate federal agencies, state legislative committees, private companies, and health care institutions will also be admitted.

The program is designed to develop both analytical skills and substantive knowledge of the health care system through an intensive and carefully designed sequence of sessions that will employ a variety of instructional formats, including both lectures and case discussions. Emphasis will be placed on the political economy of the health system, on the use of statistical data, decision theory, and cost-benefit analysis, and on the use of organizational analysis. Among the substantive and administrative problems covered during the program are quality of care regulation, certificate of need procedures, mechanisms for controlling hospital costs and prices, manpower planning, enforcement and inspection techniques, legal constraints and initiatives, and the impact of community and political pressures on the regulatory process.

For further information contact: Administrative Director for Regulation Programs, Executive Programs in Health Policy and Management, Harvard School of Public Health, 677 Huntington Avenue, Boston, MA 02115. Phone (617) 734-3300 ext. 2601.

ERRATUM

There is an error in the References of the Emergency Room Triage paper which appears in October AJPH, Vol. 65, No. 10, pp. 1063-1068, 1975. In reference 11, the year should read 1971 rather than 1972.